Phase contrast x-ray microscopy with singular optics

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Optical schemes that enable imaging of the phase shift produced by an object have become popular in the x-ray region, where phase can be the dominant contrast mechanism. Singularities in the phase have been found to be a common feature of phase retrieval and imaging with coherent fields [1]. Optics that introduce phase singularities can also play a unique role in microscopy [2]. Production of x-ray vortices containing phase singularities was recently demonstrated with refractive optics [3]. Here, we report on use of diffractive optics to produce intense x-ray vortices and their application to hard x-ray phase contrast imaging in a full-field transmission microscope. This method offers some advantages for phase contrast x-ray microscopy and does not require a Zernike phase ring. This work is supported by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under Contract DE-AC02-06CH11357.

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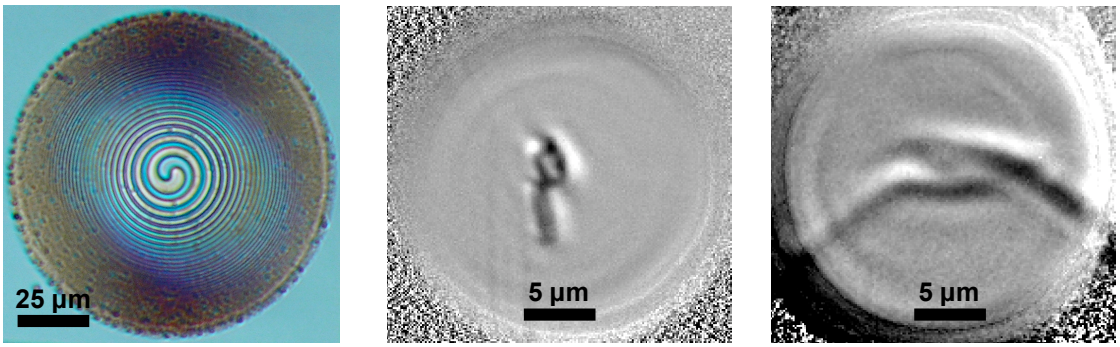

(a) Focusing diffractive x-ray vortex optic. Full-field phase contrast micrographs of (b) a silicaceous diatom and (c) two strands of spider silk recorded with 9 keV x-rays.